

COMPARISON OF THE HAND-HELD POLARIMETER AND THE GISS SUNPHOTOMETER

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ABSTRACT:

Data was taken on November 1st, 1999 between 1500 and 1518 local time (3 pm and 3:18pm) on the rooftop at the Goddard Institute for Space Studies (GISS) with the Multi-filter Rotating Shadow-band Radiometer (MFRSR) and the Hand-Held Polarimeter. The Hand-Held Polarimeter is an expensive device, which is built by a student at a cost of \$50, and the MFRSR Sunphotometer is a professional device that costs \$16,000. Both instruments provide us with results for the aerosol optical thickness and the aerosol particle size. A comparison for these values was then made.

PROJECT DESCRIPTION:

- Taking data using the Hand-Held Polarimeter to determine the aerosol particle size, the aerosol optical depth, and the aerosol refractive index.
- Analyzing data using IDL program to retrieve the best fit plots of the degree of polarization versus the scattering angles.
- Obtaining the aerosol optical depth's plot and the aerosol particle size's plot using the Multi Filter Rotating Shadow Band Radiometer (MFRSR).
- Comparing the aerosol particle size, and the aerosol optical depth obtained by using both instruments: the Hand-Held Polarimeter and the MFRSR.

DISCUSSION:

The Hand-Held Polarimeter is an expensive device that provides us with the information about atmospheric characteristics of aerosols concerning the aerosol optical depth, the aerosol particle size, and the aerosol refractive index. In order to collect three different set of data using three different color wavelengths (blue-428nm, green-527nm, red-635nm), all hand-held polarimeter's optics should be clean and do not have any finger prints and/or dust; all electronics has to be verified in terms of the connections. We need to select a clear day with no clouds or a day with a very few clouds; set up the polarimeter; record the day, the time, and the sky condition; the polarimeter is aimed towards the sun and angles of observation are varied with respect to the sun. The rotation of the Polaroid detects the polarized light and generates the maximum intensity and the minimum intensity spectra. As soon as data was collected, it was preliminary plotted using Excel to observe the data behavior; the zenith angle was sought using the day and the time when the data was taken; a data file was created and the program was run using IDL that generates a plot of actual data versus model data. On November 1st 1999 between 1500 and 1518, data was collected and analyzed by varying the radius from .1 μ to .5 μ and the optical depth from .03 to .11 to retrieve results of the radius that lie between .20 and .30 and results of the optical depth that vary between .07 and .10, and a value of the refractive index of 1.40. After the data analysis was completed, the best fit plots was sought whereby the table that present different values of radius and optical depth can be determined as it is shown in the following page.

GISS Rooftop Hand-held Polarimeter Results for Different Radii and Optical Thickness at 550nm

Data taken on November 1st, 1999

Time: 15:04 – 15:18

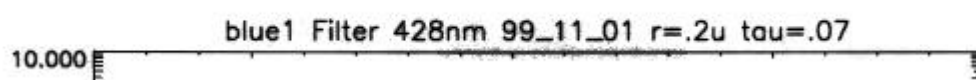
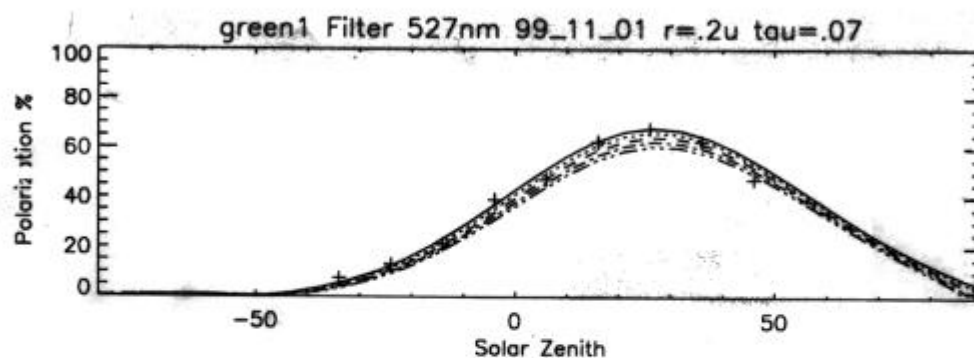
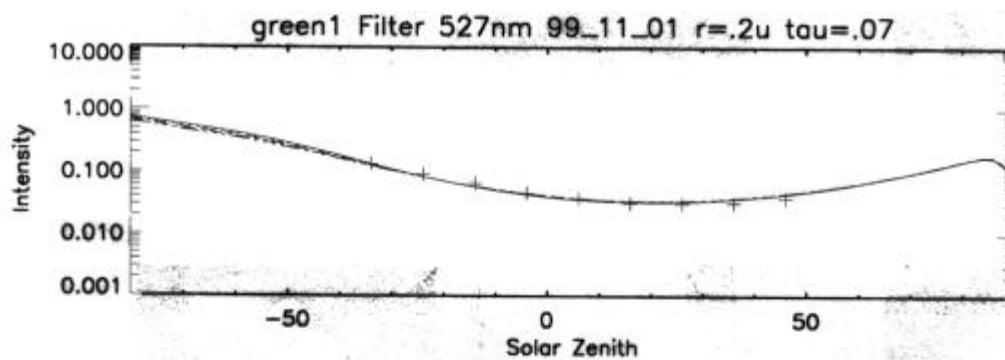
Sky: Clear, no clouds at all

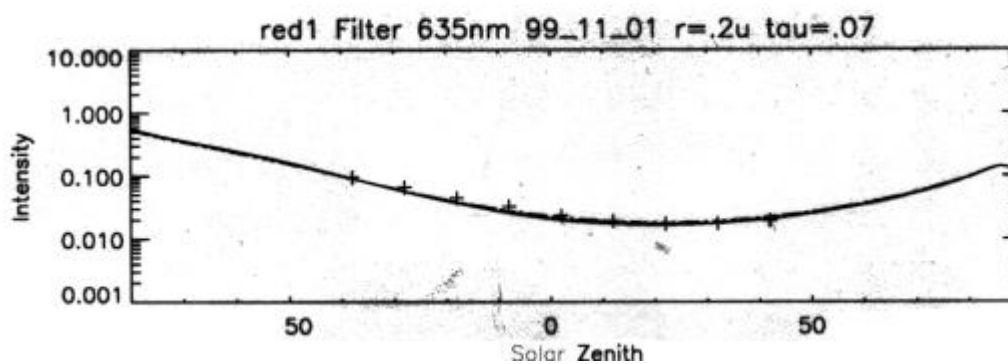
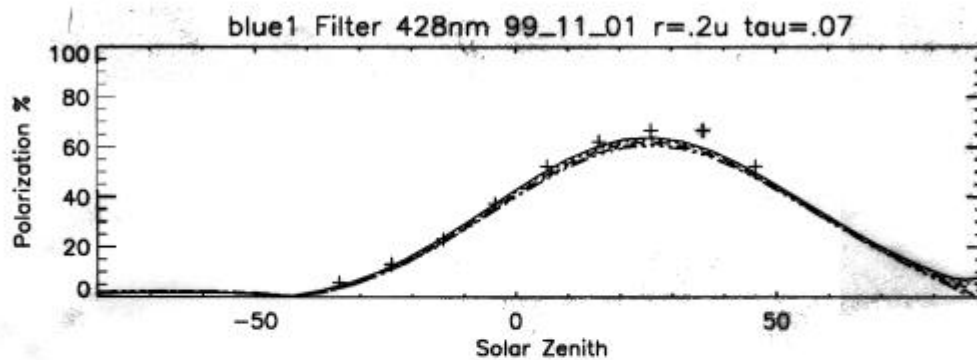
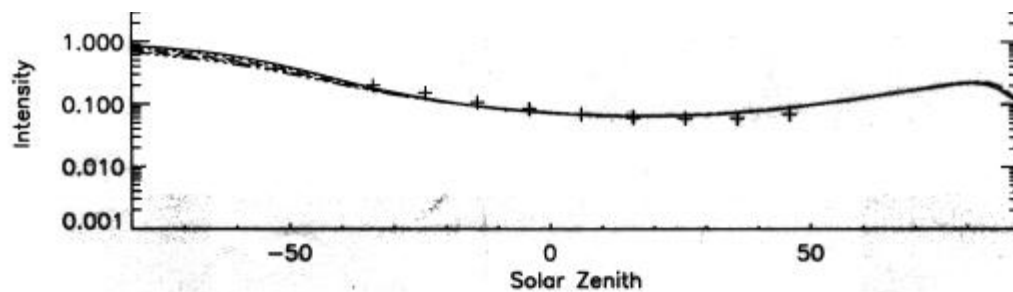
		RADIUS ^(microns)				
		.1	.2	.3	.4	.5
OPTICAL THICKNESS	.03				×	×
	.04				×	×
	.05	×	×	×	×	×
	.06	×	×	×	×	×
	.07	×	√	√	×	×
	.08	×	√	√	×	×
	.09	×	√	√	×	×
	.10	×	√	×	×	×
	.11	×	×	×	×	×

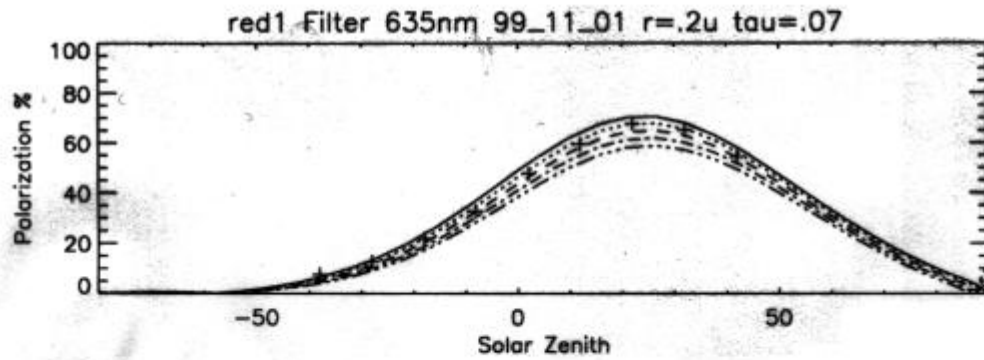
Results show that the best fit plots give an aerosol radius between .2μ – .3μ, an aerosol optical thickness between .07 – .10, and an aerosol refractive index of 1.40.

Comparing these results to the Multi Filter Rotating Shadow-band Radiometer's result, we find out that the MFRSR gives us results for the particle size that lie between .2m and .25m and results for the optical depth that vary from .10 to .12.

Sample of best fit plots which present graph of intensity as a function of the scattering angles and a graph of the degree of polarization versus the scattering angles using three different color wavelengths (Red1-635nm, Green1-527nm, Blue1-428nm) where the radius is .2m and the optical depth is .07. In order for these plots to be considered the best fit plots, the actual data which is represented by solid line has to fit the model data for all three different color wavelengths. (plots are shown on the next pages)







Conclusion:

Results for the GISS Sunphotometer were an aerosol optical depth between .10 and .12 and an aerosol particle size between .20 μ m and .25 μ m. The Hand-Held Polarimeter gave values of .07 to .10 for the optical depth and a value between .20 μ m and .30 μ m for the radius. The values for the radius agree exactly. The Hand-Held Polarimeter values for the optical depth are close but somewhat below the MFRSR values. In addition, the Hand-Held Polarimeter gave a value of 1.40 for the refractive index, whereas the Sunphotometer does not measure the refractive index.

Future Work:

- Repeat this work several times in order to verify the agreement between the Hand-Held Polarimeter and the MFRSR Sunphotometer results concerning the aerosol optical thickness and the particle sizes.
- Incorporate a mini-spectrometer in the Hand-Held Polarimeter in order to increase the number of color filter wavelengths and the resolution of the instrument. This will result in increasing the

accuracy of the Polarimeter results